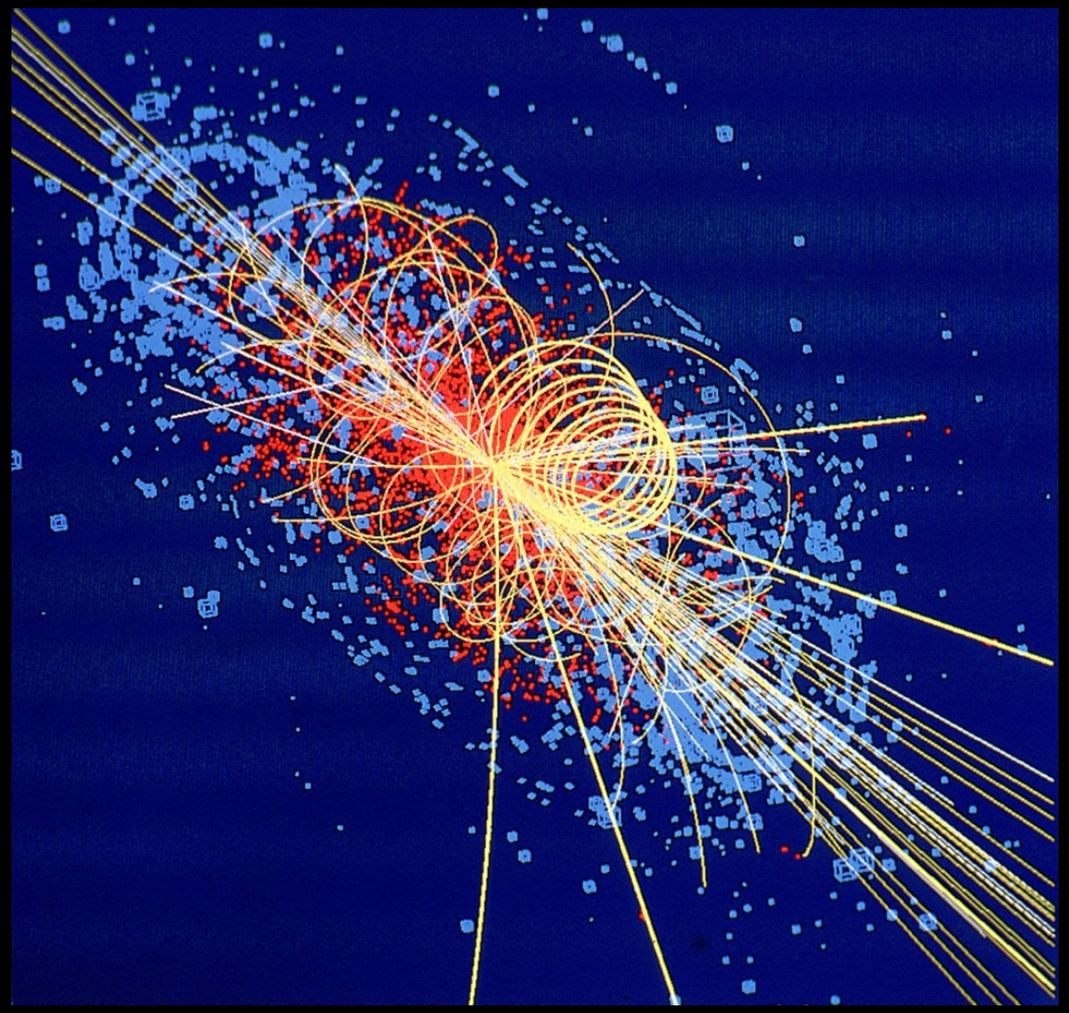
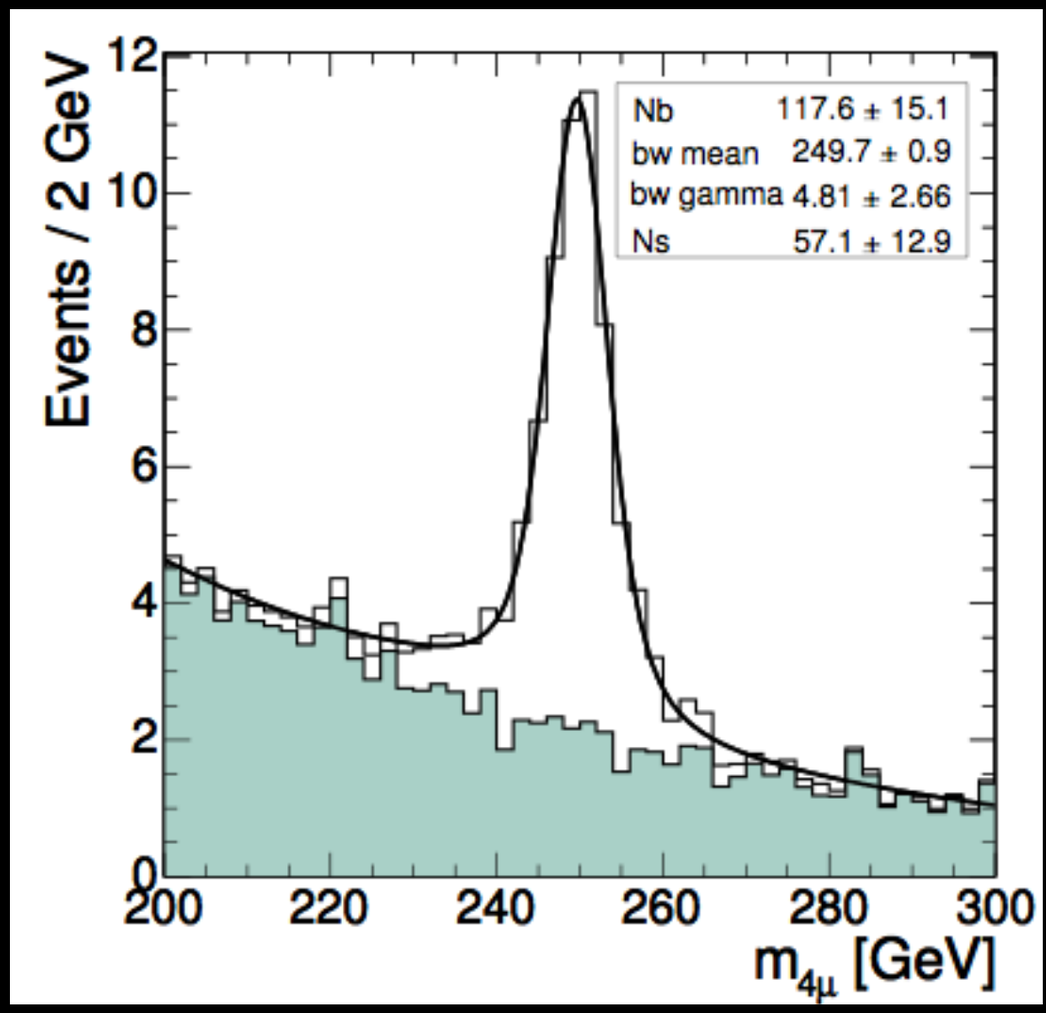
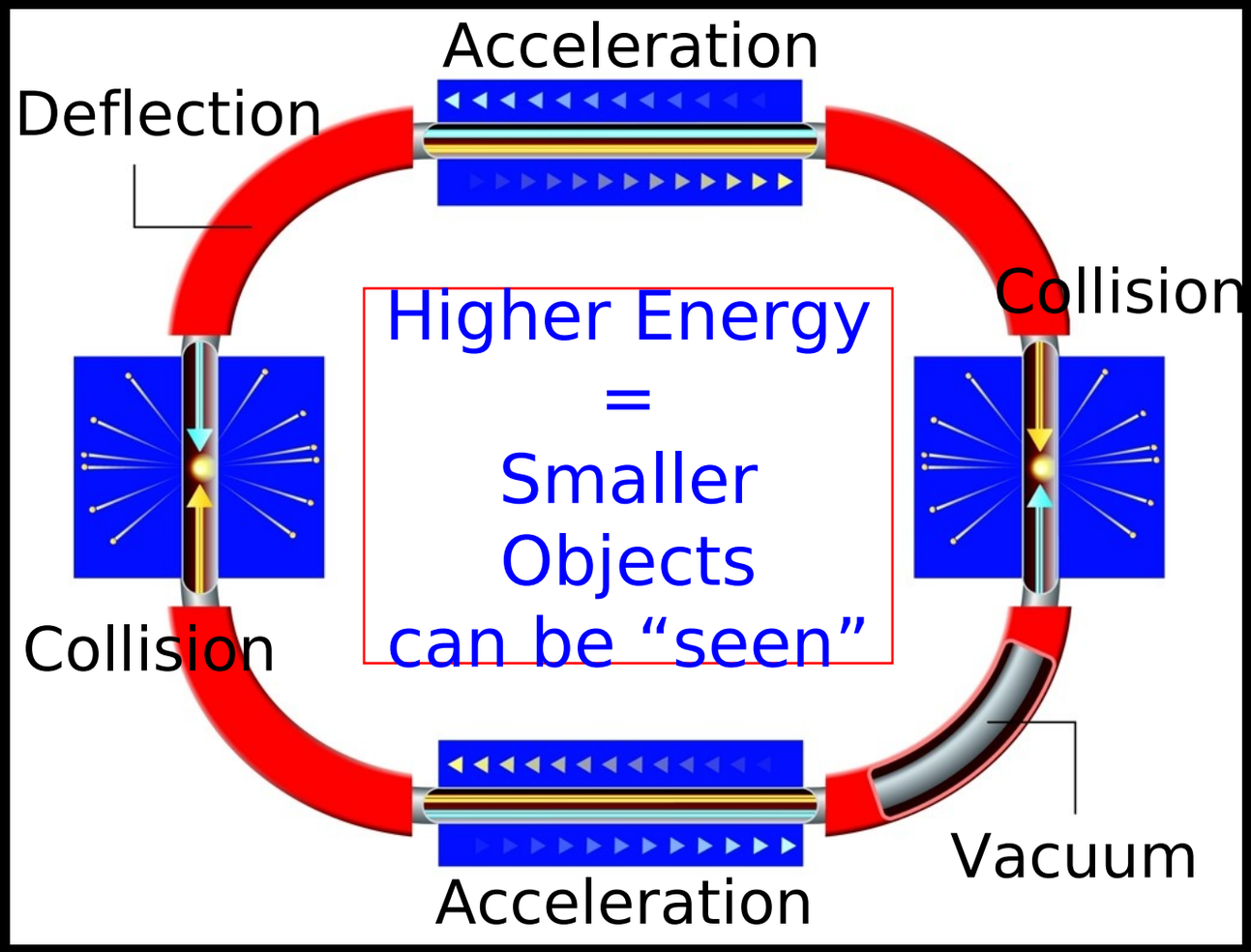
CMS Global Analysis



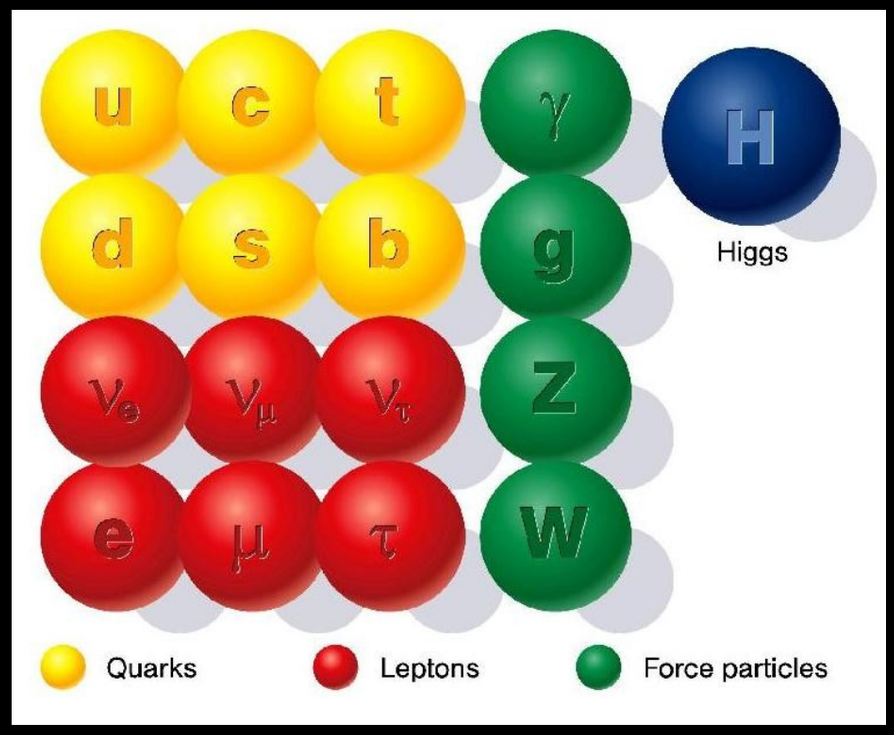


Eric Vaandering - Fermi National Accelerator Laboratory

Particle Physics



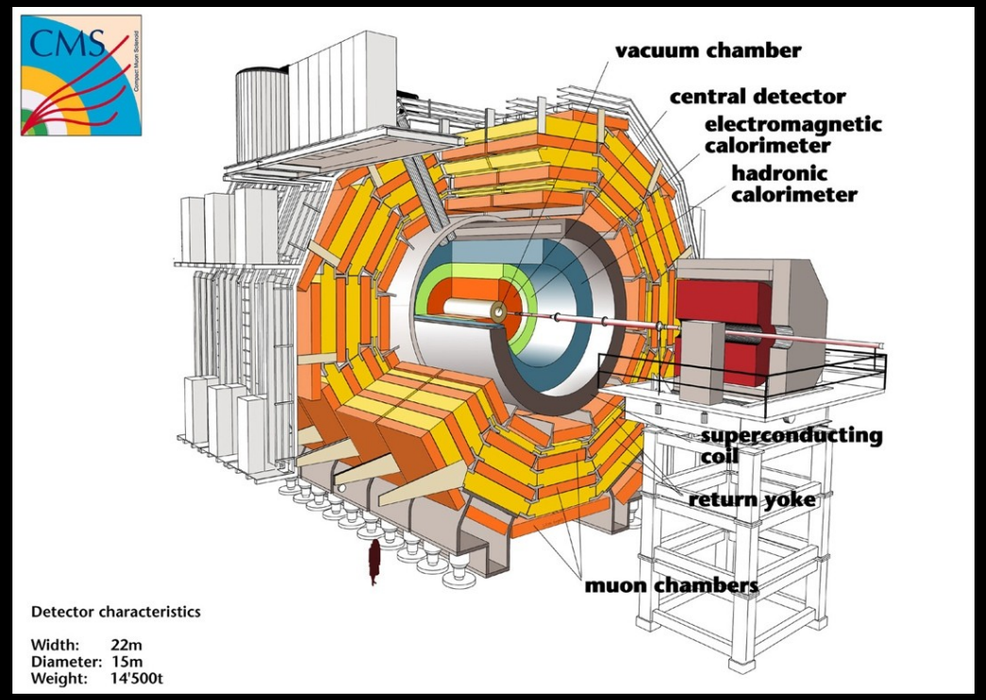
- Describe structure of matter using mathematical concepts: **Standard Model**
  - **Higgs**: concept to describe mass of particles
    - not discovered yet ➠ LHC



- Investigate structure of matter by
  - Colliding elementary particles
  - Detecting collision products

LHC and CMS

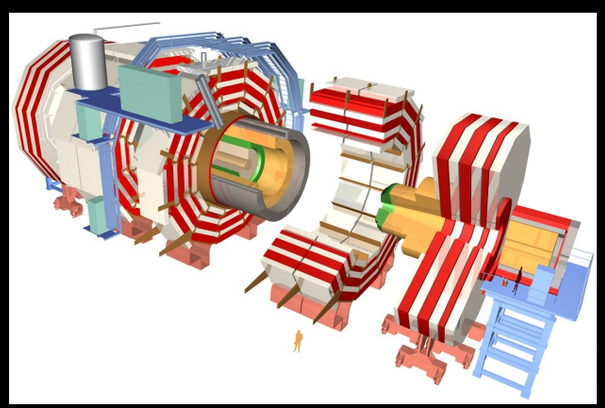
- **L**arge **H**adron **C**ollider at CERN, Geneva, Switzerland
  - Proton-Proton collisions
  - Beam energy: 7 Terra Electron Volts
    - ➡ 40 t truck hitting wall at 90 MPH
  - Circumference: 27 km



- **C**ompact **M**uon **S**olenoid:One of 4 particle collision detectors at the LHC
- Width: 22m, Diameter: 15m
- Weight: 14,500 t
- International collaboration of **3000** scientists

CMS Data Analysis

- Collisions occur at **40 MHz**
- Trigger reduces to **200 Hz**
- Output contains all recorded detector signals and derived information, called “Event”
- Events are analyzed separately (High degree of parallelization)



Data recording:
1.8 MB/evt.

Simulation:
2.5 MB/evt.

- Estimated number of recorded and simulated events
- 2008: **300 million**
- 2009: **3 billion**
- Peta-scale data volumes
- 2008: **640 TeraByte**
- 2009: **6400 TeraByte**

CMS Tier Structure

- 3000 physicists scattered around the globe want to analyze CMS data
- Analysis is location driven
  - "Job is sent where the data is stored."
- CMS follows GRID approach to distribute data storage and processing world-wide

CERN
- data recording

USA
- Recorded and simulated events

UK
- Distributed across all Tier 1 centers

Italy
- Tier 1 main function:

France
- Store events on tape for backup

GER
- Provide access to events

Spain
- For extraction of sub-samples of analysis interests

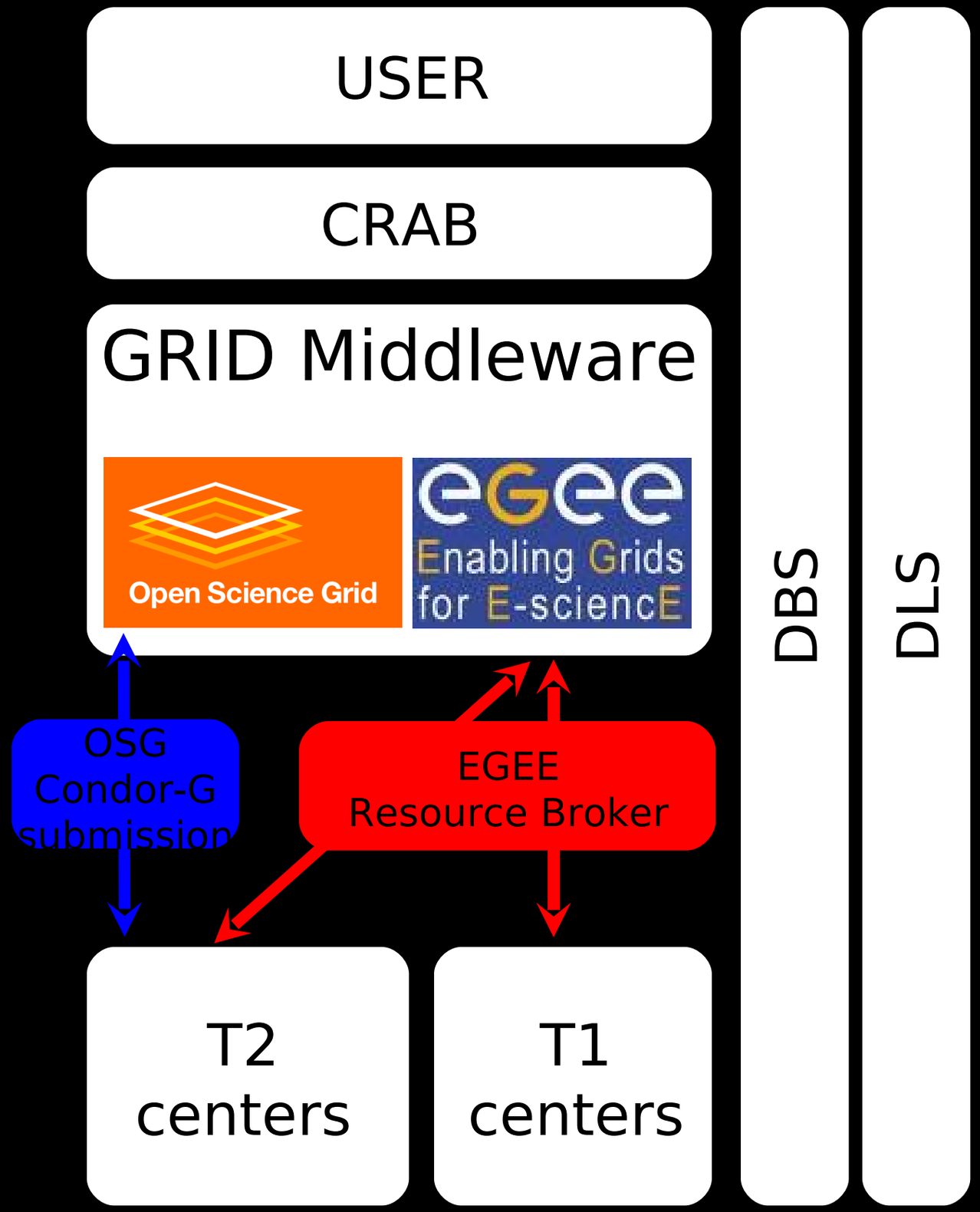
Taiwan

- Extracts of recorded and simulated events
- Distributed between Tier 2 centers (several replicas)
- Tier 2 main function:
- Provide access to events
- for user analysis

1 Tier 0 | 7 Tier 1 | ~25 Tier 2

Global Data Access

- Equal fair share access for all CMS users
- User tool: **C**MS **R**emote **A**nalysis **B**uilder
- Global Data Discovery Services:
  - **D**ata **B**ookkeeping **S**ervice
  - **D**ataset **L**ocation **S**ervice
- GRID submission:
  - EGEE resource broker submission to all centers
  - OSG Condor-G submission to OSG T2



DEMO

Summary & Outlook

- CMS Global Analysis provides all CMS users with access to **peta-scale** data volumes
  - distributed world-wide
  - accessible via GRID structure
- Infrastructure achieves current performance goals

Simulated Signal